Health Canada | Santé Canada
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Proposed Acceptability for Continuing Registration

PACR2007-05

Re-evaluation of Atrazine (Environmental Assessment)

The purpose of this document is to inform registrants, pesticide regulatory officials and the Canadian public that Health Canada's Pest Management Regulatory Agency (PMRA) has completed an environmental risk assessment as part of the re-evaluation of atrazine. This assessment follows the human health risk assessment of atrazine described in Proposed Acceptability for Continuing Registration (PACR) Document PACR2003-13, *Re-evaluation of Atrazine*, and in Re-evaluation Decision Document RRD2004-12, *Atrazine*, published on 19 November 2003 and 25 May 2004, respectively.

This PACR document provides a summary of the environmental data and information reviewed as well as the rationale for the proposed regulatory decision for atrazine. The PMRA will accept written comments on this proposal up to 60 days from the date of publication of this document. All comments should be forwarded to Publications at the address below.

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Executive Summary

Health Canada's Pest Management Regulatory Agency (PMRA) has re-evaluated the environmental aspects of the active ingredient atrazine and its associated end-use products registered for use as a herbicide on corn. This assessment follows the human health risk assessment described in Proposed Acceptability for Continuing Registration document PACR2003-13, *Re-evaluation of Atrazine*, published on 19 November 2003 and in Re-evaluation Decision Document RRD2004-12, *Atrazine*, on 25 May 2004. The health assessment concluded that the use of atrazine and its end-use products on corn does not entail an unacceptable risk to human health provided that mitigation measures are implemented. The required mitigation measures described in those documents have since been implemented.

In this environmental risk assessment document, the PMRA is also proposing that the use of atrazine and associated end-use products is acceptable for continuing registration, provided that the proposed mitigation measures described in Appendix II of this document and of RRD2004-12 are implemented. The environmental risk assessment addresses the use in Canada, excluding British Columbia for which the registrants have requested voluntary removal from the label. The environmental risk assessment did not result in any changes to the conclusions of the human health risk assessments as summarized in PACR2003-13 and RRD2004-12. The requirement for submission of monitoring data for drinking water concentrations has been fulfilled.

Atrazine poses the highest acute risks to non-target terrestrial plants through spray drift and to freshwater plants in small static aquatic habitats through surface runoff, and a high chronic risk to the aquatic community in small static aquatic habitats (e.g., wetlands, shallow ponds) through surface runoff. Precautionary measures (e.g., buffer zones) can be implemented to mitigate these risks. Additional water monitoring data are also necessary to assess the exposure risk to salmon smolts in the Atlantic provinces.

Proposed mitigation measures required to protect the environment are as follows:

1. The observance of buffer zones to protect non-target terrestrial and aquatic habitats from spray drift.

2. Precautionary measures on atrazine end-use product labels to minimize the risk of aquatic contamination from surface runoff and to mitigate the downward movement of atrazine through soil, thereby reducing groundwater contamination.

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1.0 Introduction

The re-evaluation of the active ingredient atrazine was first announced in June 1988 in Announcement 88-01, *Re-evaluation of Atrazine*, by Agriculture and Agri-Food Canada.[1] Following the announcement, an industry-led Label Improvement Program (LIP) was launched in the early 1990s. The LIP resulted in the reduction of rates of application and the deletion of some use patterns.

On 19 November 2003, the PMRA published PACR2003-13, *Re-evaluation of Atrazine*, for public consultation. That PACR described the outcome of the human health risk assessment conducted by the PMRA. The PMRA received comments from the public and interested parties on the health risk assessments as well as limited environmental comments. The comments received and the PMRA's responses were published in RRD2004-12 on 25 May 2004.

The human health risk assessment as described in PACR2003-13 and RRD2004-12 concluded that the use of atrazine and its end-use products as a herbicide on corn does not entail an unacceptable risk to human health provided that proposed mitigation measures are implemented. These measures include removal of unsupported uses from the label, a limit of 2 applications and a total of 1.5 kg a.i./ha applied per year, water soluble packaging for wettable powders and wettable granules, additional personal protective equipment, buffer zones and preharvest intervals.

As noted in RRD2004-12, this PACR document describes the outcome of the PMRA's environmental risk assessment and completes the re-evaluation of the herbicide atrazine and its end-use products. The environmental risk assessment addresses the use in Canada, excluding British Columbia for which the registrants have requested voluntary removal from the label.

2.0 Re-evaluation of Atrazine

Products containing the herbicide atrazine were first registered in Canada in 1960. Atrazine is a broad-spectrum triazine herbicide registered for the control of broadleaf and grassy weeds in corn. The technical registrants of atrazine in Canada are Syngenta Crop Protection Canada, I.Pi.Ci. Industria Prodotti and Makhteshim-Agan of North America Inc. The currently registered commercial products containing atrazine are listed in Appendix I.

A re-evaluation of atrazine was first announced in June 1988 by Agriculture and Agri-Food Canada, under the authority of Section 19 of the Pest Control Product Regulations. An outcome of that re-evaluation initiative was an industry-led LIP that was launched in early 1990s. The LIP resulted in the reduction of rates of application and the deletion of some use patterns (i.e., industrial and residential use). The use rates were reduced from 4.5 kg a.i./ha to a maximum of 1.5 kg a.i./ha for corn.

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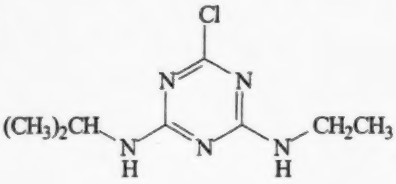
[1] Agriculture and Agri-Food Canada was the federal department responsible for administering the *Pest Control Products Act* prior to the formation of the PMRA in April 1995.

The data cited in this assessment document were obtained largely from reviews conducted by the United States Environmental Protection Agency (USEPA). The USEPA review of atrazine can be referenced for further details regarding scientific studies used by the PMRA. These reviews, as well as other information on the regulatory status of atrazine in the United States, can be found on the USEPA website. Additional data from published and unpublished scientific literature and monitoring data from federal and provincial governments were also considered.

2.1 Chemical Identification

Common name:	Atrazine
Chemical structure:	
Chemical name:	6-chloro-N^2-ethyl-N^4-ethyl-N^4-isopropyl-1,3,5-triazine-2,4-diamine
Chemical family:	Triazines
CAS number:	1912-24-9
Molecular formula:	$C_8H_{14}ClN_5$
Molecular weight:	215.7
Vapour pressure:	40 µPa at 20°C

2.2 Description of Uses

Herbicides containing atrazine are currently registered for use on corn. At the present time, a total of 12 Commercial class end-use products are registered for use on corn, among which 7 products contain only atrazine, while the remaining 5 contain at least 1 other active ingredient in addition to atrazine. Atrazine may be formulated as a wettable powder (WP), wettable granule (WG) and suspension (SU). Atrazine herbicides can be used on various types of corn, i.e., field corn, silage corn, sweet corn, popcorn and corn for seed production, glufosinate-ammonium-tolerant corn hybrids and glufosinate-ammonium-tolerant inbred corn lines grown for seed production.

Atrazine herbicides are registered for control of certain broadleaf weeds and some grassy weeds. Atrazine products can be applied preplant, preplant incorporated, pre-emergence or postemergence in either conventional tillage or minimum tillage programs. These products must be applied before corn plants reach 30 cm in height. Based on previous assessments, atrazine products can be applied once or twice per year, but the maximum amount of atrazine used in a year can not exceed 1.5 kg a.i./ha.

3.0 Human Health Assessment

The results of the human health assessment and the mitigation measures were published in PACR2003-13 and RRD2004-12. The PMRA concluded that the use of atrazine and its end- use products does not entail an unacceptable risk to human health provided the proposed mitigation measures are implemented.

As a requirement resulting from the atrazine re-evaluation, the technical registrants were required to conduct a drinking water monitoring study to confirm the background levels of atrazine in Canadian raw and finished drinking water as outlined in PACR2003-13. Expected environmental concentrations (EECs) were not found to exceed the acute and chronic drinking water level of concern for the most sensitive populations. However, the monitoring data originally received by the PMRA was limited and insufficient to fully characterize exposure potential. Syngenta Crop Protection Canada Inc. initiated a sampling program in April 2005 at 10 water treatment plants located in the provinces of Ontario and Quebec, which represent the major atrazine use area in Canada. The sites were chosen to represent the most vulnerable drinking watersheds.

Syngenta submitted a report to the PMRA. The Agency has reviewed the report and has determined that the study 1) is scientifically sound and 2) clearly demonstrates the levels of atrazine that are expected in both raw and finished drinking water. The total chlorotriazine levels detected in the monitoring study are below both the Canadian drinking water guideline for atrazine (5 µg/L) and the chronic drinking water level of concern (41.9 µg/L) reported in PACR2003-13. As such, the PMRA has determined that the levels of atrazine present in Canadian drinking water do not pose a risk to human health. The PMRA concludes that Syngenta has satisfied the drinking water monitoring study requirements outlined in PACR2003-13 and the sampling program was completed at the end of March 2006.

4.0 Environmental Assessment

The environmental risk assessment method used by the PMRA is a deterministic evaluation that integrates the environmental exposure, represented by the EEC, and the environmental toxicity, represented by the most sensitive test species, to determine the likelihood of adverse ecological effects. One method of achieving this integration is through the estimation of a risk quotient (RQ). The RQ is calculated by comparing a threshold toxicity endpoint, usually a no observed

effect concentration or level (NOEC or NOEL)[2] or an effect concentration at 25% (EC_{25}) (for terrestrial plants) for the most sensitive test species, to an EEC based on the maximum application rate. The EEC can result from overspray (100% deposition), spray drift or surface runoff (see Section 4.2). The mathematical relationship between RQ, toxicity endpoint and the EEC is:

$$RQ = EEC \div \text{toxicity endpoint}$$

For describing the environmental risk associated with the RQ, the PMRA has adopted a layered interpretation, based on the risk categorization scheme outlined in Table 1. This categorization scheme and its interpretive approach have been used in this risk assessment of atrazine.

Table 1 The PMRA Classification of Environmental Risk Quotients

Risk Quotient	Risk Category
≤ 0.1	Negligible risk
> 0.1 – < 1.0	Low risk
> 1.0 – < 10	Moderate risk
> 10 – < 100	High risk
> 100 – < 1000	Very high risk
≥ 1000	Extremely high risk

In addition to the RQ, an indicator of risk in birds and mammals is the number of feeding days on contaminated food to reach the toxicity endpoint of concern (acute oral toxicity). If the number of feeding days is less than one, then there is a concern and, conversely, if the number of feeding days is greater than or equal to one day, then there is no concern from acute oral toxicity.

The results of this deterministic assessment identified various levels of risk to non-target organisms that could potentially be exposed to atrazine.

4.1 Environmental Fate

Atrazine is soluble in water (33 mg/L) and has low volatility from moist soil and water as based on the Henry's law constant (2.61×10^{-4} Pa·m^3/mole). Atrazine has a low potential for bioaccumulation based on the *n*-octanol–water partition coefficient (log K_{ow} = 2.7) and is not expected to dissociate at environmentally relevant pH (pK_a = 1.7) as atrazine is a base.

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2 In cases where a NOEC or NOEL is not available for a test organism, one-tenth of the LC_{50} or LD_{50} is used as a conservative effects level.

Hydrolysis is not an important route of transformation at environmental pH, as atrazine is stable in aqueous solution at pH 5, pH 7 and pH 9. The only transformation product of hydrolysis is hydroxyatrazine (HA) under acidic conditions (23% of applied atrazine at pH 5.0). Phototransformation on soil is not an important route in the transformation of atrazine as the half-life is 12 days under natural sunlight. The only major phototransformation product detected in soil is desethylatrazine (DEA) at 17.4% of the applied atrazine. The DT_{50} of atrazine on leaf foliage is 13 days. Similarly, phototransformation in water is not an important route in the transformation of atrazine as the half-life is 335 days under natural sunlight.

The primary route of degradation in soil and water is biological degradation by microbes, which leads to complete mineralization. The range of DT_{50} values reported for laboratory aerobic soil dissipation studies is very wide (18–480 days). However, the studies that were reviewed included some outliers that were done in non-standard conditions of temperature and soil moisture. Taking these details into consideration, the majority of relevant laboratory studies indicate that the aerobic soil DT_{50} of atrazine is between 40 and 115 days with a mean of 61 days. Based on this range of values, atrazine is moderately persistent in soil under aerobic conditions. In anaerobic soil, atrazine is moderately persistent (DT_{50} = 77–159 days). In aerobic–aquatic systems, atrazine is moderately persistent to persistent (DT_{50} = 80 to > 400 days). Atrazine is persistent in anaerobic aquatic systems (DT_{50} = 330–608 days); thus, anaerobic aquatic biotransformation is not an important route in the transformation of atrazine.

Atrazine has medium to very high mobility in soil (adsorption K_{oc} = 39–155). The transformation products of atrazine are highly mobile to very highly mobile in soil with the exception of HA that is immobile to moderately mobile in soil. The mobile transformation products include DEA, desisopropylatrazine (DIA) and diaminochlorotriazine (DACT). Under field conditions, the majority of the applied material dissipates from the root zone, but traces of atrazine residues can leach into soil depths greater than one metre at approximately one year after application. Atrazine is subject to transport from treated fields through surface runoff. Dissolved atrazine accounts for greater runoff losses than from atrazine bound to eroded soil. Results of field studies have shown that the surface runoff from corn fields is expected to be ≤ 2% of the applied atrazine.

Atrazine is used as a herbicide for corn, and the majority of corn in Canada is grown in the mixed wood plains ecozone of Ontario and Quebec. The dissipation of atrazine under Ontario field conditions has been reported in several studies published in open literature showing atrazine to be moderately persistent (half-life = 56–125 days). Under conditions representative of the temperate prairie ecozone in Canada, atrazine is reported to dissipate much more slowly (1^{st} order DT_{50} = 261–402 days). However, the calculations used to obtain these values were inappropriate in some cases because the data did not fit the simple first order kinetic model. Therefore, the use of a first order kinetic model with linear regression is inappropriate. The use of non-linear regression methods significantly improves the fit to the original data and with further model refinement by excluding time intervals when soil would be frozen, periods during which metabolic processes and physical movement of atrazine residues are essentially stopped, the estimated DT_{50}s (58–99 days) are comparable to the majority of those determined from laboratory aerobic soil studies as well as those reported in field dissipation studies conducted in Ontario. Estimated DT_{90}s, however, show that atrazine remains in soil for a relatively long

period (279–694 days). The results indicate that long-term annual applications of atrazine lead to the potential carryover of residues, which can persist beyond the final season of application. Based on field measurements from Ontario and those representative of the temperate prairie ecozone, the carryover of atrazine into the subsequent growing season is < 10–41% and 33–54%, respectively. Transformation products are first detected in soil at 450 days after the application of atrazine. Transformation products may persist in soil as subsequent detections can occur at 571–938 days after the first detection.

Based on lake enclosure experiments and measurements of atrazine in Swiss lakes, atrazine is moderately persistent to persistent in lake water (DT_{50} = 150 days to stable). Results from artificial stream experiments show no significant accumulation of atrazine in sediments. In marine/estuarine systems, atrazine has been shown to be non-persistent to moderately persistent (DT_{50}s range from 3 to 120 days).

Atrazine is detected in the atmosphere, in areas removed from agricultural sites. Deposition of atrazine into surface waters occurs through gas exchange, particulate deposition and precipitation. The highest concentrations of atrazine in air (vapour + particulate) are expected to coincide with the application period. The degree of contribution of atmospheric deposition of atrazine to surface water contamination is not known.

The bioconcentration potential of atrazine is low as the bioconcentration factors in fish are 7.7–15. The relatively low concentrations of atrazine that accumulated in fish are rapidly depurated (74–78%) after 21 days of depuration in atrazine-free medium.

4.2 Expected Environmental Concentrations

The expected concentrations in habitats of concern are estimated using simple scenarios in which environmental compartments (e.g., terrestrial habitats, aquatic habitats or food sources) receive the maximum label rate (overspray) of atrazine used in corn (1.5 kg a.i./ha). These concentrations are used in an initial risk assessment for identifying the potential risk to aquatic and terrestrial non-target organisms. A refined risk assessment is conducted in cases where the overspray EECs pose an unacceptable risk to non-target organisms. In this assessment, more refined scenarios based on spray drift and/or surface runoff were used to determine more realistic EECs. In addition, EECs can also be determined using monitoring data. In the case of atrazine, there is a large amount of quality water monitoring data for the major use areas, Ontario and Quebec.

The initial terrestrial assessment is achieved by using an EEC based on the maximum application rate of atrazine of 1.5 kg a.i./ha (Table 2). To refine the assessment, the EECs are calculated using the exposure scenario for off-target areas receiving 10% of the maximum rate of atrazine or 0.15 kg a.i./ha. The 10% of the maximum application rate, represents the approximate amount of atrazine entering a non-target area through spray drift deposit without the observance of a buffer zone (as there is no current label requirement for a buffer zone for the protection of

terrestrial habitats)[3]. The 10% spray drift value is derived from a spray drift model for groundboom sprayer using medium spray quality (ASAE)[4] as based on the data of Wolf and Caldwell (2001). In addition, the surface runoff EEC for exposure to terrestrial plants is 2% of the maximum application rate (0.03 kg a.i./ha). The 2% of applied rate is derived from the upper limit of atrazine losses from agricultural use due to surface runoff. Table 2 outlines the EEC in terrestrial habitats resulting from spray drift and surface runoff.

Table 2 EECs for Terrestrial Habitats

Exposure Scenario	Terrestrial EECs (kg a.i./ha)
Maximum rate	1.5
Spray drift deposit	0.15
Surface runoff	0.03

For exposure through consumption of contaminated food, the EECs were determined for atrazine on food sources that would be ingested by wild birds and mammals following a maximum single rate of atrazine (1.5 kg a.i./ha). The EECs were determined according to the scheme of Hoerger and Kenaga (1972) and Kenaga (1973), and modified according to Fletcher et al. (1994).

The initial aquatic assessment is achieved by using the EEC resulting from the deposition of atrazine at the maximum application rate (1.5 kg a.i./ha) into a lentic (i.e., non-flowing) aquatic system (Table 3). The scenario for a lentic system is a one-hectare pond that is 80-cm deep.

In refining the aquatic assessment, the EEC in lentic systems was calculated using the exposure scenario of a one-hectare pond that is 80-cm deep receiving 0.64% of the maximum rate of atrazine (9.6 g a.i./ha). The 0.64% of the maximum rate, would be the approximate amount of atrazine entering a non-target area through spray drift with the observance of a 10-m buffer zone (as there is a current label requirement for a 10-m buffer zone for protection of aquatic habitats). This value (0.64% spray drift) was derived from a spray drift model for groundboom sprayers as based on the data of Wolf and Caldwell (2001). Table 3 outlines the EEC in aquatic habitats resulting from spray drift.

Furthermore, the EECs in lentic systems resulting from surface runoff was estimated using the combined Pesticide Root Zone Model and Exposure Analysis Modeling System PRZM/EXAMS[5]. Historical meteorological data and soil characteristics data from a corn-growing region of Quebec, were used as inputs for the PRZM/EXAMS. The scenario was surface runoff from a treated 10-hectare watershed entering a one-hectare pond that is 80-cm

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3 Recall that all atrazine products require the observance of a 10-m buffer zone for protection of aquatic habitats only for groundboom sprayer applications.

4 ASAE: American Society of Agricultural Engineers

5 PRZM version 3.12 and EXAMS version 2.98

deep. The model estimated the 90th percentile of the highest yearly values for the peak, 96-hour, 21-day, 60-day, 90-day and the mean yearly concentrations. The estimation of the EEC takes into account the physical-chemical properties and the transformation rates of atrazine.

In subsequent refinements, EECs were also calculated using the PRZM/EXAMS at the Tier 1 level for scenarios specific to Nova Scotia. Historical meteorological data and soil characteristics data from corn-growing regions of Nova Scotia were also used as inputs for the PRZM/EXAMS. The scenario was modified to allow flow through the water body to better simulate salmon smolt habitat, and the soil half-life value was modified from initial runs to be more reflective of degradation in soil . The models were run to encompass a 20-year time frame with 10 starting dates between 14 April and 14 June, a period that coincides with Atlantic salmon smolt migration from freshwater to seawater (McCordick et al. 1998). The 90th percentile of the highest values for the peak, 96-hour, 21-day, 60-day, 90-day and the mean yearly concentration estimated for Nova Scotia over this time period are shown in Table 3.

Table 3 EECs for Aquatic Habitats

Exposure scenario	Aquatic (µg a.i./L)					
Maximum rate	188					
Spray drift deposit[a]	1.2					
Surface runoff[b]	Peak	96-hour	21-day	60-day	90-day	Yearly mean
Quebec	110	109	106	98	92	35
Nova Scotia	32	31	29	26	23	10

a EEC in aquatic habitats resulting from observance of a 10-m spray buffer zone as based on data of Wolf and Caldwell (2001).

b EECs in aquatic habitats generated by PRZM/EXAMS are 90th percentile of the highest yearly concentrations.

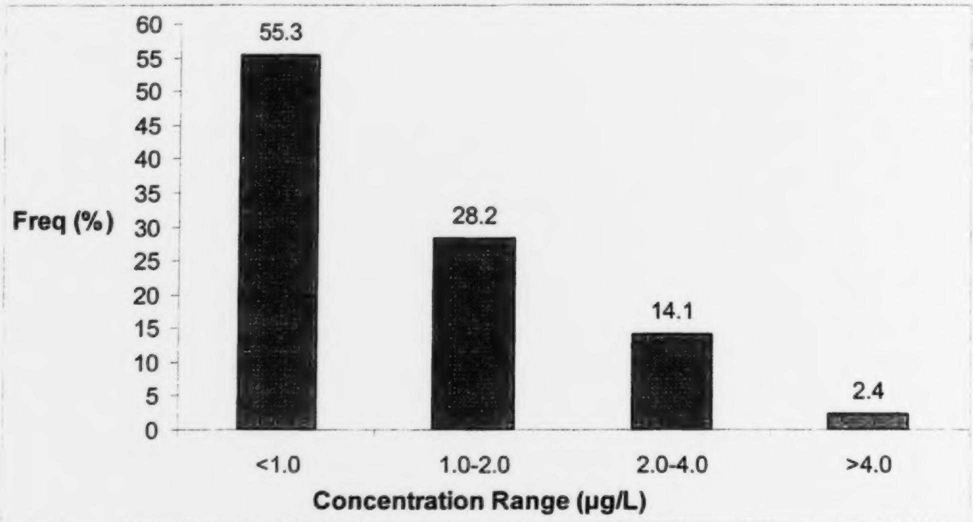
In assessing ambient concentrations of atrazine, monitoring data for Canadian surface waters were considered. The monitoring data were obtained from published studies, the environment ministries of Alberta, Ontario and Quebec, Environment Canada and from unpublished monitoring results from Environment Canada's Pesticide Science Fund activities in 2003–2004. As there were label changes in 1993 where the maximum application rate of atrazine in corn was reduced to 1.5 kg a.i./ha, only post-1993 monitoring data on atrazine concentrations in Canadian waterways were considered. The monitoring data available to the PMRA represent lotic systems (e.g., larger rivers) and smaller bodies of water (i.e., creeks, streams and farm ditches). The majority of the data was collected from sites in the corn-growing region of Ontario and Quebec. In most cases, sampling was conducted over the entire growing season (May–August), and many of the sites were sampled consecutively for two or more seasons. Table 4 summarizes the range of mean and absolute maximum concentrations of atrazine obtained from the monitoring data. Figure 1 illustrates the distribution of mean atrazine concentrations. The transformation products

DEA and DIA were detected in 45–100% and 47–100%, respectively, of the water samples monitored by the ministère du Développement durable, de l'Environnement et des Parcs du Québec (Quebec ministry of the environment). For atrazine, the PMRA has determined there are sufficient monitoring data for major use areas in Ontario and Quebec for the environmental risk assessment.

Table 4 Summary of Atrazine Concentrations Detected in Canadian Surface Water After 1993

Range of Means (µg/L)	Range of Absolute Maximum (µg/L)
0.02–5.75	0.05–26

Figure 1 Distribution of Mean Atrazine Concentrations in Canadian Surface Waters After 1993



4.3 Environmental Toxicology

Atrazine is relatively non-toxic to terrestrial invertebrates on an acute contact basis. The acute contact LD_{50} is 96.7 µg a.i./bee, which is equivalent to an application rate of 108.3 kg a.i./ha. An approximation of the NOEL is 9.7 µg a.i./bee (1/10 LD_{50}), which is equivalent to an application rate of 10.8 kg a.i./ha.

In birds, atrazine is slightly toxic to practically non-toxic on an acute oral toxicity basis (LD_{50} = 940–4237 mg a.i./kg). An approximation of the acute NOEL (1/10 LD_{50}) in the most sensitive species is 94.0 mg a.i./kg. On a subacute dietary basis, atrazine is practically non-toxic to birds (LC_{50} = 5760–19 560 mg a.i./kg diet). An approximation of the subacute NOEC (1/10 LD_{50}) in the most sensitive species is 576.0 mg a.i./kg diet. On a reproductive toxicity basis, the NOEC is 225 mg a.i./kg diet.

Atrazine is slightly toxic to practically non-toxic to mammals on an acute basis (LD_{50} = 1332 mg a.i./kg). An approximation of the acute NOEL (1/10 LD_{50}) in the most sensitive species is 133.2 mg a.i./kg. On a subchronic and chronic basis, the NOECs are 50 and 70 mg a.i./kg diet, respectively, in the rat, for decrease in body weight, body-weight gain and food consumption. In reproductive and developmental studies, the NOEC is 134 mg a.i./kg diet in the rabbit, for decrease in body weight and food consumption (maternal) and decrease in the number of live offspring per litter.

In terrestrial plants, the EC_{25} values for reduction in the dry weight of crop species are 0.003 to < 4.0 kg a.i./ha and 0.008 to < 4.0 kg a.i./ha for seedling emergence and vegetative vigour, respectively. The most sensitive crop species are carrot (*Daucus carota*) for seedling emergence (EC_{25} = 0.003 kg a.i./ha) and cucumber (*Cucumis sativus*) for vegetative vigour (EC_{25} = 0.008 g a.i./ha).

Atrazine is slightly toxic to highly toxic to freshwater aquatic invertebrates on an acute basis (LC_{50} = 720 to > 33 000 µg a.i./L). An approximation of the acute NOEC (1/10 LC_{50}) in the most sensitive species is 72 µg a.i./L. On a chronic basis, atrazine causes reproductive effects in freshwater invertebrates with reported NOECs of 60–10 000 µg a.i./L. Monitoring data indicate the presence of the transformation products, DIA and DEA in lotic systems. Currently, there are no data on the acute toxicity of these products on freshwater invertebrates.

In freshwater fish, atrazine is slightly to moderately toxic on an acute basis (LC_{50} = 5300–27 000 µg a.i./L). An approximation of the acute NOEC (1/10 LC_{50}) in the most sensitive species is 530 µg a.i./L. On a subchronic basis (early life stage), the LC_{50}s are 220–880 µg a.i./L. An approximation of the subchronic NOEC (1/10 LC_{50}) in the most sensitive species is 22 µg a.i./L. On a chronic basis (life-cycle), the NOEC values are 65–210 µg a.i./L. Monitoring data indicate the presence of the transformation products, DIA and DEA in lotic systems; however, there are no data on the acute toxicity of these products on freshwater fish.

The acute toxicity of atrazine in amphibians is similar to that of fish (LC_{50}s = 410–10 700 µg a.i./L). An approximation of the acute NOEC (1/10 LC_{50}) in the most sensitive species is 41 µg a.i./L.

The reproductive and developmental effects of atrazine in amphibians are inconclusive based on the current data. In June 2003, under the auspices of the USEPA, the available data (laboratory and field studies) on reproduction and development in amphibians underwent an evaluation according to the review process of the *Federal Insecticide, Fungicide, and Rodenticide Act* (FIFRA) Scientific Advisory Panel (SAP). The SAP consisted of experts in the appropriate scientific disciplines including representation from the PMRA. The SAP agreed with the initial USEPA evaluation that, the available data do not establish a concordance of information to indicate whether atrazine will cause adverse reproductive and developmental effects in amphibians. The SAP, therefore, recommended the request for additional studies to address the uncertainty in the reported effects. Details on the evaluation of these studies are outlined in the USEPA document, *White Paper on Potential Developmental Effects of Atrazine on Amphibians - In Support of an Interim Reregistration Eligibility Decision on Atrazine*.

Aquatic plants were the most sensitive freshwater organisms to atrazine. The EC_{50} values for inhibition in growth are 25–959 and 21–20 000 µg a.i./L in freshwater algae and vascular plants, respectively. An approximation of the acute NOECs (1/10 EC_{50}) in the most sensitive species are 2.5 and 2.1 µg a.i./L, for freshwater algae and vascular plants, respectively. The transformation products DIA and DEA are less toxic than atrazine. Atrazine is 10–69 and 7–12 times more toxic to freshwater algae than DIA and DEA, respectively.

Atrazine induces community-level effects on aquatic systems. These effects include inhibition in O_2 production, reduction in phytoplankton and periphyton biomass as well as subsequent effects on the population of zooplankton and macroinvertebrate species. On the basis of these community-level endpoints, the NOEC for aquatic plant communities is estimated to be 5.0 µg a.i./L.

Although, exposure to atrazine in marine/estuarine systems is expected to be minimal given the current use pattern (corn), toxicology data for marine/estuarine organisms were reported. In marine/estuarine invertebrates, atrazine is slightly toxic to very highly toxic on an acute basis (LC_{50} = 88–13,300 µg a.i./L). On a chronic basis, the NOEC is 80 µg a.i./L in marine/estuarine invertebrates.

Atrazine is slightly toxic to moderately toxic to marine/estuarine fish on an acute basis (LC_{50} = 1000–16 200 µg a.i./L). In an early life-stage study, mortality was observed in Atlantic salmon that were transferred to seawater following 5 days of continuous exposure to atrazine in freshwater; the NOEC (mortality) was estimated to be 0.5 µg a.i./L. This endpoint is based on a study by Waring and Moore (2004) and is the more conservative endpoint estimate of two similar toxicity experiments reported in the same study. A comparison between the mortality effects shown by the two experiments and the ones observed in a similar study conducted by the same authors (Moore et al., 2003) shows there is some uncertainty in the reproducibility of the data; however, the atrazine concentrations that are shown to elicit mortality effects in Atlantic salmon smolts (after exposure in freshwater and subsequent transfer to seawater) are within an order of magnitude of each other.

In marine/estuarine plants, the EC_{50} values are 22–400 µg a.i./L in algae (inhibition in biomass and growth rate) and 4–30 000 µg a.i./L in vascular plants (inhibition in biomass, leaf growth, shoot length).

4.4 Terrestrial Risk Assessment

The terrestrial vascular plants are the most susceptible terrestrial organisms to atrazine. The acute RQs are based on the EC_{25}s of 0.008 kg a.i./ha (vegetative vigour) and 0.003 kg a.i./ha (seedling emergence) for the most sensitive species. There is a high acute risk to vegetative vigour (RQ = 18.8) in terrestrial plants that is attributed to spray drift resulting from the ground application of atrazine without the observance of a no-spray buffer zone. Similarly, there is high acute risk to seedling emergence (RQ = 10) in terrestrial plants that is attributed to surface runoff.

In terrestrial invertebrates, the exposure to atrazine is not a concern as there is a low acute risk (RQ = 0.14) based on an overspray exposure equivalent to the maximum application rate (1.5 kg a.i./ha) and the NOEC for the most sensitive species (10.8 kg a.i./ha).

In birds, the acute risk is not a concern. On an acute oral toxicity basis, individual birds would have to feed continuously for more than a day (1.2 days) on food contaminated with atrazine to reach the no observed effect level (NOEL) of 94.0 mg a.i./kg in the most sensitive species. Thus acute effects in birds are not expected under field conditions. Similarly, on a subacute dietary toxicity basis, the risk is not a concern as the RQ (0.46) indicates a low risk based on the NOEC of 576 mg a.i./kg diet in the most sensitive species. On a chronic toxicity basis in birds, atrazine is not a concern as it requires 85.7% of the bird's diet to be contaminated with atrazine to result in a RQ of 1.0. As birds would have to consume such a large proportion of their diet as contaminated food for an extended duration and given that atrazine is not persistent on vegetation (DT_{50} = 13 days), such an exposure is not likely under field conditions. Thus, chronic effects in avian species are not expected.

In small mammals, the acute risk is not a concern. On an acute oral toxicity basis, individual animals would have to feed continuously for one day on food contaminated with atrazine to reach the NOEL of 133.2 mg a.i./kg in the most sensitive species. Therefore, acute effects in small mammals are not expected. On a subchronic and chronic basis, the initial assessment indicates a high risk to small mammals (RQ = 10.8 and 15.1, respectively). An additional assessment indicates that consumption of relatively small proportions of the animal's diet as contaminated food (6.6–9.3%) results in a RQ of 1.0. Atrazine is not persistent on vegetation (DT_{50} = 13 days) and chronic exposure through contaminated food sources is not likely; therefore, it is not a concern in small mammals. Similarly, on a reproductive and developmental toxicity basis, the assessment indicates that consumption of relatively small proportions of the animal's diet as contaminated food (11.8%) results in a RQ of 1.0; however, as atrazine is not persistent on vegetation (DT_{50} = 13 days), chronic exposure through contaminated food sources is not likely and thus, not a concern in small mammals.

4.5 Aquatic Risk Assessment

For the aquatic risk assessment, it is the PMRA's policy to consider both monitoring data (when available) and EECs generated using water models as part of its overall risk assessment. Although valid monitoring data are considered preferable to modelled EECs, the weight given to these data varies depending on the circumstances. As previously noted, for atrazine, there is sufficient water monitoring data for Ontario and Quebec.

Freshwater habitats that are situated adjacent to corn fields where atrazine is applied, have the highest potential for exposure to atrazine through surface runoff and spray drift. By contrast, the exposure to marine habitats through surface runoff and spray drift is limited given the use pattern of atrazine (i.e., corn-growing regions of Ontario and Quebec). Therefore, the risk resulting from exposure for organisms exposed while in marine systems is not a concern. Species that migrate from freshwater to marine system are included in freshwater assessments.

The results of the aquatic risk assessment are summarized in Table 5. For freshwater organisms, in general risks to all taxonomic groups from exposure via spray drift were acceptable providing specified buffer zones are observed. Risks were identified for all taxonomic groups to varying degrees based on EECs determined from modelling for surface water runoff. Potential for effects on invertebrates, acute effects on amphibians and effects in freshwater fish (other than anadromous salmonids) were categorized as moderate. Risk for effects on individual species of aquatic plant and plant communities were categorized as low to high. Additional water monitoring work will be required to confirm the risk to anadromous salmonids.

When monitoring data are considered, the risk profile is different. For the purposes of the assessment, a relatively conservative approach was used. Acute risk was characterized using the absolute maximum concentration from monitoring data, and chronic risk was characterized using the maximum mean value for the various data sets considered.

Potential risk to invertebrates, fish (other than anadromous salmonids) and acute effects in amphibians are categorized as low, whereas risk for effects on individual species of aquatic plants and plant communities were categorized as moderate or high.

Given that effects on aquatic plants were a specific area of concern, a further refinement to the assessment was done. Using the distribution of mean concentrations from the various data sets used, it was determined that effects from atrazine exposure are not a concern at the community level as 98% of the mean ambient concentrations are below the NOEC of 5.0 µg a.i./L.

Given the quantity and quality of monitoring data for Ontario and Quebec the PMRA has determined that environmental risk conclusions for these regions should be based on the assessment conducted using monitoring data.

The other region in Canada where atrazine is currently used on corn is in the maritime provinces (Nova Scotia, New Brunswick and Prince Edward Island). Use in these areas is less than in the major corn-growing regions of Ontario and Quebec. However, unlike Ontario and Quebec, the assessment was conducted to consider of potential effects on anadromous salmonids as these are the most sensitive species in these regions.

The modelled EEC estimated for an exposure scenario specific to Nova Scotia during salmon smolt migration period (32 µg/L for peak concentration, Table 3) represents a high-end potential exposure. Based on these values, atrazine is shown to pose a high risk to salmon smolts (RQ = 64).

Unlike Ontario and Quebec, available monitoring data for atrazine in the eastern maritime provinces is not as robust. Sampling has been conducted infrequently over broad intervals that would be insufficient to capture maximum atrazine concentrations and at times that do not coincide with potential atrazine use and the period of salmon smolt migration. Interpretation of assessment results needs to consider that based on monitoring data from other regions of Canada and the United States, peak concentrations of atrazine typically occur shortly after application, a time period that coincides with smoltification, but which is not well characterized in the current monitoring data.

Based on the available monitoring data from the eastern maritime provinces, atrazine was characterized as low to moderate risk to salmon smolts undergoing the transition process from freshwater to saltwater (RQ = 0.3) based on the NOEC of 0.5 µg a.i./L for Atlantic salmon and the absolute maximum surface water concentration of atrazine detected in potential salmon habitats of the maritime provinces (0.15 in Nova Scotia).

Given the limited surface water monitoring data for atrazine in Nova Scotia to assess the potential risk to salmonids undergoing smoltification, the PMRA has concluded that monitoring is necessary to assess the exposure risk to salmon smolts during the smolt migration period.

As noted earlier, there is considerable scientific debate on the effects of atrazine on amphibian reproduction. The chronic risk to amphibians will be addressed upon receipt of the newly generated data on reproductive and developmental effects.

Although, there were no major transformation products (> 10% of applied) detected under aquatic laboratory conditions at environmentally relevant pH, the transformation products DIA and DEA, were detected in the available monitoring data. The available data indicated that DIA and DEA are significantly less phytotoxic than atrazine; consequently, there is a lower risk to aquatic plant communities from these transformation products. There are no available data, however, on the toxicity of DIA and DEA to aquatic invertebrates and fish; therefore, these data should be submitted to fully address the risk of exposure to these transformation products in aquatic habitats.

Table 5 Summary of Aquatic Risk Assessment Results

Taxonomic Group	Test Exposure	Aquatic Habitat	Route(s) of Deposition	Risk (RQ)	Risk Category	Conclusions / Refined Risk
Freshwater invertebrates	Acute	Lentic (modelled)	Surface runoff	1.6	Moderate	Risk from surface runoff
			Spray drift	0.02	No risk	Spray drift not a concern
		Lotic (monitoring data)	All	0.36	Low	Not a concern
	Chronic	Lentic (modelled)	Surface runoff	1.9	Moderate	Risk from surface runoff
			Spray drift	0.02	No risk	Spray drift not a concern
		Lotic (monitoring data)	All	0.1	Low	Not a concern

Taxonomic Group	Test Exposure	Aquatic Habitat	Route(s) of Deposition	Risk (RQ)	Risk Category	Conclusions / Refined Risk
Freshwater fish (not including anadromous salmon species)	Acute	Lentic (modelled)	Surface runoff	0.22	Low	Surface runoff and spray drift not a concern
			Spray drift	0	No risk	
		Lotic (monitoring data)	All	0.05	No risk	Not a concern
	Subchronic	Lentic (modelled)	Surface runoff	5.4	Moderate	Risk from surface runoff
			Spray drift	0.05	No risk	Spray drift not a concern
		Lotic (monitoring data)	All	0.26	Low	Not a concern
	Chronic	Lentic (modelled)	Surface runoff	1.6	Moderate	Risk from surface runoff
			Spray drift	0.02	No risk	Spray drift not a concern
	Chronic	Lotic (monitoring data)	All	0.09	No risk	Not a concern
Freshwater fish (anadromous salmon species)	Subchronic	Lentic (modelled)	Surface runoff	64*	High	Monitoring data required
		Lotic (monitoring data)	All	0.3	Low	
Freshwater amphibians	Acute	Lentic (modelled)	Surface runoff	2.9	Moderate	Risk from surface runoff Spray drift not a concern
			Spray drift	0.03	No risk	
		Lotic (monitoring data)	All	0.63	Low	Not a concern
	Chronic	Both	All	ND	TBD	Risk characterization pending additional data on chronic effects
Freshwater algae	Acute	Lentic (modelled)	Surface runoff	47	High	Risk from surface runoff Spray drift not a concern
			Spray drift	0.5	Low	
		Lotic (monitoring data)	All	2.3	Moderate	Risk mainly from surface runoff Range of mean ambient concentrations indicates a risk

Taxonomic Group	Test Exposure	Aquatic Habitat	Route(s) of Deposition	Risk (RQ)	Risk Category	Conclusions / Refined Risk
Freshwater vascular plants	Acute	Lentic (modelled)	Surface runoff	55.7	High	Risk from surface runoff Spray drift not a concern
			Spray drift	0.57	Low	
		Lotic (monitoring data)	All	2.7	Moderate	Risk mainly from surface runoff Range of mean ambient concentrations indicates a risk
Freshwater aquatic community	Chronic	Lentic (modelled)	Surface runoff	22.9	High	Risk from surface runoff Spray drift not a concern
			Spray drift	0.24	Low	
		Lotic (monitoring data)	All	1.2	Moderate	Not a concern as 98% of the mean ambient concentrations are below toxicity threshold (NOEC)
Marine/ estuarine invertebrates	Acute	Lentic (modelled)	Surface runoff	13.4	High	Surface runoff not a concern as exposure is limited in marine/estuarine habitats Spray drift not a concern
			Spray drift	0.14	Low	
	Chronic	Lentic (modelled)	Surface runoff	1.5	Moderate	Surface runoff not a concern as exposure is limited in marine/estuarine habitats Spray drift not a concern
			Spray drift	0.02	No risk	
Marine/ estuarine fish	Acute	Lentic (modelled)	Surface runoff	0.6	Low	Surface runoff and spray drift not a concern
			Spray drift	0.01	No risk	
	Chronic	Lentic (modelled)	Surface runoff	234	Very high	Surface runoff and spray drift not a concern as exposure is limited in marine/estuarine habitats
			Spray drift	2.4	Moderate	
Marine/ estuarine algae	Chronic	Lentic (modelled)	Surface runoff	54	High	Surface runoff not a concern as exposure is limited in marine/estuarine habitats Spray drift not a concern
			Spray drift	0.55	Low	
Marine/ estuarine vascular plants	Acute	Lentic (modelled)	Surface runoff	293	Very high	Surface runoff and spray drift not a concern as exposure is limited in marine/estuarine habitats
			Spray drift	3	Moderate	

ND = not determined, TBD = to be determined.

*Based on peak EEC values for Nova Scotia.

4.6 Toxic Substances Management Policy

During the review of atrazine, the PMRA has taken into account the federal Toxic Substances Management Policy[6] (TSMP) and has followed its Regulatory Directive DIR99-03[7]. It has been determined that atrazine does not meet the TSMP Track 1 criteria for the following reasons.

- Atrazine is not bioaccumulative. The *n*-octanol–water partition coefficient (log K_{ow}) is 2.7, which is below the TSMP Track 1 cut-off criterion of log $K_{ow} \geq 5.0$.

- Atrazine meets the criteria for persistence as its maximum DT_{50} values in water (> 400 days), and soil (480 days) are above the TSMP Track 1 cut-off criteria for water (≥ 182 days) and soil (≥ 182 days). No data were provided for persistence of atrazine in air.

- The toxicity of atrazine is addressed in Section 4.3.

- Hexachlorobenzene has been identified as a microcontaminant in technical atrazine. Hexachlorobenzene is considered a TSMP Track 1 substance as it meets all the criteria for bioaccumulation and persistence. Furthermore, it does not meet the criteria of the *Canadian Environmental Protection Act* (CEPA) for CEPA-toxic or CEPA-toxic equivalent under the TSMP. As described in Regulatory Directive DIR99-03, the PMRA will work with registrants to reduce/eliminate microcontaminants of concern in line with the best available technology from a manufacturing perspective and encourage the development of new technology.

4.7 Environmental Concerns

Of the different terrestrial organisms, atrazine poses the highest acute risk to non-target terrestrial plants. As this exposure to atrazine in terrestrial plants occurs through spray drift, precautionary measures (e.g., buffer zone) can be implemented to mitigate the risk.

In aquatic organisms, atrazine poses the highest acute risk to freshwater plants in small static aquatic habitats (e.g., wetlands, shallow ponds) where the atrazine exposure is through surface runoff. Similarly, on the basis of community-level endpoints (O_2 production, phytoplankton and periphyton biomass and populations of zooplankton and macroinvertebrate species), atrazine poses a high chronic risk to the aquatic community in small static aquatic habitats (e.g., wetlands, shallow ponds) where the atrazine exposure is through surface runoff.

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6 The federal Toxic Substances Management Policy is available through Environment Canada's website at www.ec.gc.ca/toxics.

7 Regulatory Directive DIR99-03, *The Pest Management Regulatory Agency's Strategy for Implementing the Toxic Substances Management Policy*, is available through the Pest Management Information Service. Phone: 1-800-267-6315 within Canada or 613-736-3799 outside Canada (long distance charges apply); fax: 613-736-3798; e-mail: pmra_infoserv@hc-sc.gc.ca; or through our website at www.pmra-arla.gc.ca.

Although a risk is identified for individual species of freshwater plants based on the range of ambient atrazine concentrations in aquatic habitats (rivers) within the corn-growing regions, on the basis of community-level endpoints (O_2 production, phytoplankton and periphyton biomass and populations of zooplankton and macroinvertebrate species) the exposure to atrazine in these systems is considered not to be a concern because 98% of the ambient concentrations measured in aquatic systems are below the toxicity threshold for community effects (NOEC = 5.0 µg/L).

In conducting environmental risk assessments, it is the PMRA's policy to consider both monitoring data (when available) and EECs generated using water models as part of its overall risk assessment. Although valid monitoring data are considered preferable to modelled EECs, the weight given to these data varies depending on the circumstances.

Given the limited surface water monitoring data available for atrazine in Nova Scotia to assess the risk to salmonids undergoing smoltification, the PMRA has concluded that monitoring is necessary to assess the risk during the smolt migration period to further assess the exposure risks to salmon smolts.

Reported corn production in each of the East Coast provinces is 2604, 6065 and 2719 ha in Prince Edward Island, Nova Scotia and New Brunswick, respectively. The percentage of agricultural land that is corn cropped within the East Coast provincial subdivisions is also low (Table 6). Although the RQ based on the limited surface water monitoring data indicates that atrazine does not pose a risk to salmon smolts on the East Coast (RQ < 1), the majority of the sampling was not conducted in areas of corn production, and none of the samples were collected at times that coincide with the smolt migration period. In contrast, the RQ based on the modelled EECs generated specifically for Nova Scotia during the smolting period (RQ > 1) indicates that atrazine does pose a risk. Given this discord, the PMRA feels there is currently insufficient evidence to indicate whether the use of atrazine in the East Coast provinces poses a risk to salmon smolts.

Table 6 Comparison of Corn Production in the Coastal Provinces[1]

Province	# Subdivisions Reporting Corn Production	% of Agricultural Land Corn Cropped	# Subdivisions Reporting Corn Cropped > 1% of Total Agricultural Land Use
Prince Edward Island	21	< 0.1–1.7	4
Nova Scotia	18	< 0.1–2.3	2
New Brunswick	18	< 0.1–0.9	0

1 Values are based on 2001 Agricultural Census data.

4.8 Data Requirements

The technical grade active ingredient atrazine (PCP# 24722, 20583 and 18438) has been shown to be contaminated with chlorinated benzenes, which have been identified in the federal government's TSMP (1995) as Track 1 substances. The PMRA is continuing to pursue its efforts to implement the Agency's strategy to manage Track 1 contaminants in pest control products (DIR99-03). In August 2006, letters were sent to the technical registrants of atrazine requesting that data from the analysis of recent production batches of this technical grade active ingredient using sensitive and readily available analytical methods be submitted by March 2007. This information will be used by the PMRA to evaluate the progress being made towards the virtual elimination of chlorinated benzenes from atrazine and whether any additional measures are warranted.

As the effects of atrazine on the reproduction and development in amphibians are inconclusive, the following data, as required by the USEPA, are applicable to the PMRA as a condition to support continued registration of atrazine:

- Reproductive/developmental effects in amphibians (DACO 9.9)

Transformation products were detected in aquatic habitats; however, data on acute and chronic toxicity in freshwater invertebrates and fish were not available for review. The following studies on the transformation products DIA and DEA are required as a condition of continued registration of atrazine. The registrant has the option to submit scientifically based rationales to support data waivers:

- Acute toxicity test with *Daphnia magna* (DACO 9.3.2)
- Chronic toxicity test with *Daphnia magna* (DACO 9.3.3), pending results of acute toxicity test
- Acute toxicity tests with bluegill sunfish and rainbow trout (DACO 9.5.2.1)
- Early life-stage tests with bluegill sunfish and rainbow trout (DACO 9.5.3.1), pending results of acute toxicity test
- Life-cycle tests with bluegill sunfish and rainbow trout (DACO 9.5.3.2), pending results of acute toxicity test

As atrazine surface water monitoring data are not available for potential freshwater salmon bearing habitat (i.e., small creeks and streams) on the East Coast (Prince Edward Island, Nova Scotia and New Brunswick) during the sensitive salmon smolt migration period, it is appropriate to conduct a monitoring study of these waterways during this period. These data are required as a condition to support continued registration of atrazine in the Atlantic provinces.

- The monitoring data should focus on "high-risk sites" (i.e., areas of high corn production adjacent to salmon habitat) and be conducted within the timeframe where high atrazine concentrations are expected. In selecting these sites, some factors to be considered include topography, proximity of waterway to treated corn fields and the intensity of atrazine use as well as meteorological conditions. The registrants will be required to submit a draft protocol for review and comments, to ensure that the sampling locations, sampling times and procedures are sufficient to assess the risk to salmon smolts.

4.9 Risk Mitigation

4.9.1 Spray Drift

Atrazine can enter terrestrial and aquatic habitats through spray drift. The observance of buffer zones, however, can effectively mitigate the risk to terrestrial and aquatic plants (Appendix II). Pesticide spray drift from groundboom sprayers was predicted using the data of Wolf and Caldwell (2001). Based on the maximum application rate of 1.50 kg a.i./ha and the most sensitive terrestrial species (carrot: EC_{25} = 0.008 kg a.i./ha), a buffer zone was calculated for mitigating the entry of atrazine into terrestrial habitats. For protection of terrestrial habitats, the buffer zone is 10 meters. Terrestrial habitats include grasslands, forested areas, shelter belts, woodlots, hedgerows, pastures, rangelands and shrublands. For protection of aquatic habitats, the labelled buffer zone of 10 meters is adequate. Aquatic habitats include lakes, rivers, sloughs, ponds, prairie potholes, creeks, marshes, streams, reservoirs and wetlands.

Currently, the buffer zones determined for ground applications are based on a standard set of assumptions for spray configuration and weather conditions, yet many variable conditions exist at any spray site. To allow for increased flexibility, the PMRA is developing, together with the provinces, a proposal that would allow the applicator to factor in the actual values for spray characteristics, wind speed and to some extent, the sensitivity of the habitat to be protected. There would also be the possibility of factoring in advances in spray application technology that can reduce drift (e.g., low drift nozzles, shrouds, cones). Consequently, individual applicators could reduce the size of the spray buffer zone if they employ some of these measures to protect the habitat in question. With the use of shrouds and cones on spray booms, it has been estimated that the buffer zones can be reduced by 70% and 30%, respectively.

In addition to buffer zones, precautionary measures pertaining to spray drift should be observed and, therefore, included on product labels.

4.9.2 Surface Runoff/Leaching

Currently, there are no available methods for mitigating the impacts of pesticide transport in surface runoff. There are, however, precautionary measures that should be included on product labels to minimize the risk of aquatic contamination from surface runoff. Similarly, to mitigate the downward movement of atrazine through soil and consequently to reduce groundwater contamination, precautionary measures should be included on atrazine product labels.

5.0 Proposed Regulatory Action Relating to the Environment

Although the risks of atrazine to the environment have been found to be acceptable with implementation of all risk-reduction measures, additional scientific information is being requested as a result of this re-evaluation (see Section 4.8). This additional information is required to confirm conclusions and/or refine risk assessments. Evaluation of this information could result in changes to the risk-reduction measures on the labels of atrazine products.

The proposed measures to mitigate the risk to the environment arising from the use of atrazine are presented in Appendix II. These precautionary measures must be included together with the existing precautions indicated on atrazine labels.

6.0 Proposed Re-evaluation Decision

Based on the review of the available information, the PMRA is proposing that the use of atrazine and associated end-use products is acceptable for continuing registration, provided that the proposed mitigation measures in this document (Appendix II) and in RRD2004-12 (Appendix II) are implemented. The environmental risk assessment did not result in any changes to the conclusions of the human health risk assessments as summarized in PACR2003-13 and RRD2004-12. The requirement for submission of monitoring data for drinking water concentrations is considered fulfilled. Due to the voluntary withdrawal (distribution, sale and use) for British Columbia by the registrants, the evaluation of the use in British Columbia was not completed. Should a registrant seek to enter the British Columbia market, a science review must be completed.

Further measures may be necessary at a future date pending the submission of studies on reproductive/developmental effects in amphibians.

This PACR completes the current re-evaluation assessment of atrazine. The PMRA will accept written comments up to 60 days from the date of publication of this document to allow interested parties an opportunity to provide input into the proposed re-evaluation decision resulting from the current environmental risk assessment.

List of Abbreviations

µg	microgram
a.i.	active ingredient
bw	body weight
C	Commercial class
CEPA	*Canadian Environmental Protection Act*
cm	centimetre(s)
DACO	data code
DACT	diaminochlorotriazine
DEA	desethylatrazine
DIA	desisopropylatrazine
DIR	Regulatory Directive
DT	disappearance time
EC	effect concentration
EEC	expected environmental concentration
EXAMS	Exposure Analysis Modeling System
FIFRA	*Federal Insecticide, Fungicide, and Rodenticide Act*
h	hour(s)
ha	hectare(s)
HA	hydroxyatrazine
kg	kilogram(s)
L	litre
LC_{50}	mean lethal concentration
LD_{50}	mean lethal dose
LIP	Label Improvement Program
m	metre(s)
mg	milligram(s)
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
NOEL	no observed effect level
PACR	Proposed Acceptability for Continued Registration
PMRA	Pest Management Regulatory Agency
PRZM	Pesticide Root Zone Model
RQ	risk quotient
RRD	Re-evaluation Decision Document
SAP	Scientific Advisory Panel
SO	solid
SU	suspension
T	technical
TSMP	Toxic Substances Management Policy
USC	Use-site Category
USEPA	United States Environmental Protection Agency
WG	wettable granule
WP	wettable powder

Appendix I Registered Atrazine Products as of 5 June 2006[a]

Registrant	Registration Number	Product Name	Market Class[b]	Formulation Type[c]
BASF Canada	16641	Laddok Liquid Suspension Herbicide	C	SU
BASF Canada	19349	Marksman Herbicide	C	SU
Bayer Crop Science Inc.	26277	Converge 480 Herbicide	C	SU
Bayer Crop Science Inc.	26968	Liberty AT Herbicide	C	SU
Drexel Chemical Company	18805	Drexel Atrazine 500 Flowable Herbicide (Agricultural)	C	SU
I.Pi.Ci. Industria Prodotti Chimici Spa	20583	Atrazine Technical	T	SO
Makhteshim-Agan of North America Inc.	14616	Atrazine 90W Agricultural Herbicide	C	WP
Makhteshim-Agan of North America Inc.	24722	Atranex (Atrazine) Technical	T	SO
Makhteshim-Agan of North America Inc.	28111	Atranex 90 WDG	C	WG
Syngenta Crop Protection Canada Inc.	18438	Atrazine Technical	T	SO
Syngenta Crop Protection Canada Inc.	18450	Aatrex Liquid 480 Herbicide	C	SU
Syngenta Crop Protection Canada Inc.	25730	Primextra II Magnum Herbicide	C	SU
United Agri Products Canada Inc.	20997	Atrazine 480 Herbicide	C	SU
United Agri Products Canada Inc.	23583	Atrazine 90WG Herbicide	C	WG
United Agri Products Canada Inc.	24608	Shotgun Flowable Hericide	C	SU

[a] Discontinued products or products with a submission for discontinuation are not included.

[b] T = Technical; C = Commercial class end-use product

[c] SO = solid; SU = suspension; WG = wettable granules; WP = wettable powder

Appendix II Label Amendments for Commercial Class Products Containing Atrazine

(NOTE: This is a summary of label statements for commercial class products containing atrazine resulting from the re-evaluation on environmental risks of atrazine. This attachment does not identify all label requirements for individual end-use products such as first aid statements, disposal statements, precautionary statements and supplementary personal protective equipment that may be required. Additional information on labels of currently registered products should not be removed unless it contradicts information indicated below.)

COMMON NAME:	Atrazine
CHEMICAL NAME:	6-chloro-N^2-ethyl-N^4-ethyl-N^4-isopropyl-1,3,5-triazine-2,4-diamine
FORMULATION TYPE:	WP: wettable powder WG: wettable granules SU: suspension
SITE CATEGORIES:	USC 13: Terrestrial Feed Crops (silage, field and seed corn) USC 14: Terrestrial Food Crops (field and sweet corn, popcorn and seed corn)

All Canadian end-use product labels containing atrazine must be amended as follows.

On the primary display panel, as per the registrant request, the following statement must be added immediately below the product name:

- **DO NOT USE IN THE PROVINCE OF BRITISH COLUMBIA**

The following statements must be added to end-use product labels containing atrazine, under **ENVIRONMENTAL HAZARDS**:

- Toxic to non-target terrestrial plants and aquatic organisms. Observe the buffer zones and precautionary measures specified under Directions for Use.

Because terrestrial field accumulation/dissipation studies have shown that more than 30% of the atrazine is remaining after one use season (e.g., at beginning of the following use season), the following statement on the label is required:

- Atrazine is persistent and will carry over. It is recommended that any products containing atrazine not be used in areas treated with this product during the previous season.

The following statements must be added to end-use product labels containing atrazine under **DIRECTIONS FOR USE**:

- Do NOT apply by air.
- Do NOT apply during periods of dead calm or when winds are gusty.
- Do NOT overspray non-target terrestrial or aquatic habitats.
- Do NOT contaminate aquatic habitats when cleaning and rinsing spray equipment or containers.
- When a tank mixture is used, consult the labels of the tank-mix partners and observe the largest (most restrictive) buffer zone of the products involved in the tank mixture.

Buffer Zones

The buffer zones specified in the table below are required between the point of direct application and the closest downwind edge of sensitive terrestrial habitats (such as grasslands, forested areas, shelter belts, woodlots, hedgerows, pastures, rangelands and shrublands) or aquatic habitats (such as lakes, rivers, sloughs, ponds, prairie potholes, creeks, marshes, streams, reservoirs, wetlands and estuarine/marine habitats).

Application Method	Buffer Zone for Protection of:	
	Terrestrial Habitats (m)	Aquatic Habitats (m)
Groundboom sprayer[a]	10	10

[a] For field sprayer application, buffer zones can be reduced with the use of drift reducing spray shields. When using a spray boom fitted with a full shield (shroud, curtain) that extends to the crop canopy or ground, the labelled buffer zone can be reduced by 70%. When using a spray boom where individual nozzles are fitted with cone-shaped shields that are no more than 30 cm above the crop canopy or ground, the labelled buffer zone can be reduced by 30%.

Surface Runoff

- To reduce runoff from treated areas into aquatic habitats, consider the characteristics and conditions of the site before treatment. Site characteristics and conditions that may lead to runoff include, but are not limited to, heavy rainfall, moderate to steep slope, bare soil and poorly draining soil (e.g., soils that are compacted, fine textured or low in organic matter such as clay).
- Avoid applying this product when heavy rain is forecast.
- Contamination of aquatic areas as a result of runoff may be reduced by including a vegetative strip (buffer zone) between the treated area and the edge of the water body.

Leaching

- The use of this chemical may result in contamination of groundwater particularly in areas where soils are permeable (e.g., sand, loamy sand and sandy loam soils) and/or the depth to the water table is shallow.
- Avoid applying this product when heavy rain is forecast.

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